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Safeguarding America's Critical Technologies (and Avoiding Personal Risk)

An Introduction to Export Control and Critical Technology Restrictions

All DOD researchers, both those employed by the Federal Government and those from the industrial base, become familiar with the regulations concerning classified documents and technologies early in their career. Use of safes, secure buildings and rooms, proper handling, labeling and storage are all part of the day-to-day world of dealing with classified information. But how much do you know about export control regulations and the control of data and technologies that, while not classified, are still vital to the warfighting superiority of the U.S.?

For instance, suppose an engineer develops an improved processing method for high temperature ceramics that enables near net shape manufacture of complex parts. A paper is prepared which details the production method and various materials used, and is presented at a Materials Research Society (MRS) conference. Forty people are in attendance during this particular session, and the paper is published in the proceedings of the conference. Does this engineer realize that a law may have been broken?

The Department of Defense is congressionally mandated to maintain a list detailing those critical technologies that help maintain the superiority of U.S. armed forces. Technologies on this list are considered for integration into the Department of Commerce's export control lists, such that proliferation may be limited. In the example above, the engineer, in a public forum, presented a processing method that may produce components with performance characteristics which provide a competitive military edge over our adversaries. Since this hypothetical critical information is now available in the conference proceedings, adversary nations could utilize that engineer's work to leap ahead of their current levels of capability. In this fashion, critical technology was allowed to fall into the hands of potential enemies, thus enabling them to stay abreast of our military capabilities

The Defense Department, through the Defense Threat Reduction Agency (DTRA), presently maintains a program called the Militarily Critical Technologies Program (MCTP), whose primary purpose is to prepare the Militarily Critical Technologies List (MCTL). This list, as specified by the 1979 Export Administration Act, is part of the mechanism which seeks to identify technologies critical to U.S. interests. It provides candidate inputs and technical justification for items placed on the Commerce Control List (CCL) and International Traffic in Arms Regulations (ITAR) administered by the Departments of Commerce and State, respectively. The MCTL is also used as a reference tool for evaluating potential technology transfers and for determining whether technical reports and scientific papers are eligible for public release. (For a more detailed history of export controls and the MCTL, see the accompanying sidebar *History of Export Control Regulations*.) The current, public edition of the MCTL is on the Internet (http://www.dtic.mil/mctl) and is continually updated as progress is made on the technologies described in the basic document. For government and contractor personnel with access to the Defense Technical Information Center's STINET, a more complete version of the MCTL is available.

The MCTL provides a codification of what DOD believes to be critical to the military superiority of the U.S. In combination with sound technical judgment, the list may be used to assess whether a proposed transaction permits a technology transfer allowing potential adversaries access to technologies whose specific performance levels are at or above the characteristics identified as militarily critical. The list provides guidance, but is not an export control list in-and-of-itself. The MCTL should be used for initial guidance on the dissemination of critical technologies, and can provide input to export control policy.

Critical Technologies in Action

Within the Defense community, there are various mechanisms set up to control proliferation of critical technologies. The most obvious are the procedures for dealing with classified materials, but less obvious are those intended to protect what are called critical technologies.

The first and last line of defense for protection of critical technologies is the researcher. Initial decisions about what to publish, what talks to give, and who to talk to, represent the first step in protecting data. The next step is divisional management and/or the Public Affairs Office of specific bases or labs (for government personnel). Contractor personnel follow their own company-specific internal procedures. The decision on whether to allow something to be published or presented in a public forum is ultimately left up to an individual that has the administrative authority to control release of technology. They will often utilize the assistance of senior technical staff in making complex decisions.

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Table 1. The Three-part Militarily Critical Technology List

Weapons Systems Technologies (WST) provides details of those critical technologies whose performance parameters are at or above the minimum level necessary to ensure continuing superior performance of U.S. military systems. These technologies are selected from the population of technologies that are militarily significant (i.e., they provide measurable advantage to U.S. military systems or enhanced threats posed by potential adversaries).

Weapons of Mass Destruction (WMD) [only available in STINET] addresses those technologies required to develop, integrate, or employ biological, chemical, or nuclear weapons and their means of delivery. Technical subsections are included which cover means of delivery, information systems, biological, chemical and nuclear weapons, as well as nuclear weapon effects. Hybrid combinations of advanced and older effective technologies and innovative uses of other technologies that provide threatening weapons capabilities are also included in this section. One of the most critical issues regarding the technologies discussed in Part II is that they become militarily effective even when not developed to their full capability.

Developing Critical Technologies (DCT) identifies those critical technologies that provide new or superior performance or maintain superior capability more affordably and support one or more of the Joint Chiefs of Staff (JCS) warfighting objectives outlined in the JCS *Joint Vision 2020*. It also takes cognizance of the Secretary of Defense Quadrennial Defense Review (QDR) and defense plans. The technologies included are candidates for militarily critical technologies, international cooperative programs, and national and international export control. Because of its complexity, it is being issued section by section. Some example sections cover aeronautics, armaments and energetic materials, directed and kinetic energy technologies, lasers, optics, nuclear technology, sensors and signature control technologies. Materials and processing technologies are also covered specifically; examples include armor/antiarmor, electrical, optical, high temperature and high strength structural materials.

Table 2. Example Material Classes Included in the Weapons Systems Technologies and the Developing Critical Technologies Sections of the MCTL.

Metallics	Non-Metallics
Advanced Aluminum and Magnesium Alloys, Tungsten, Copper, Tantalum, Molybdenum and Depleted Uranium (Monolithic)	Ceramic Matrix Composites (CMCs), Polymer Matrix Composites (PMCs), Structural Carbon-Carbon Composites
Discontinuously Reinforced Metal Matrix Composites (DRMMCs)	Optical, IR Coatings, Non-linear Optics
Advanced Titanium, Titanium Matrix Composites (TMC) and Titanium Aluminide Composites	Various Composites Designed for Kinetic Energy Absorption to Resist Fragmentation or Impede Shock Wave Transmission
Gamma Titanium Aluminide	Low Thermal Expansion Structures
Advanced Intermetallic Alloys	High-Thermal Conductivity Structures
Ultralightweight Metallic Materials and Structures	Silicon Carbide, Titanium Diboride, Boron Carbide, Advanced Monolithic Ceramics
Nanocrystalline Materials and Structures	Metallic-Organic Laminates

For researchers at accredited institutions of higher learning performing fundamental research, there is a blanket exemption from the requirements of export control. According to the amended Code of Federal Regulations (CFR) Title 22, Parts 123 and 125, these institutions do not have to register the export of data or equipment produced solely for, or from, fundamental research. This policy has shifted back and forth from full and open disclosure to restricted release over the past 40 years, and currently there is congressional pressure to limit the exemption as it is currently written. The main exception to the exemption is when an academic researcher initially agrees to information restrictions as a condition of doing the research.

Beyond individual researchers and their departments, DOD has various mechanisms for controlling release of information including service-level offices and specific, joint-service offices set up for selected technology areas. These coordinating offices tend to focus on particularly sensitive technology areas such as low observables (signature reducing technologies) or directed energy (lasers, etc.). If a technology is controlled, there are criminal and civil penalties for their unauthorized dissemination, thus making the offender personally liable for the act. Additionally, companies who develop technologies (whether with government funding or not) are responsible for their control and can also be held criminally and civilly liable for unauthorized technology transfers.

Inappropriate transfer of technology is not limited to papers, journal articles, prepared talks and lectures, but can also include patents and sales of technology. In the case of defense-related patents, the Patent and Trademark Office (PTO) reviews each application for innovative merit; then it is assessed by various recognized experts within DOD. These experts will make recommendations about whether the technology is critical. If it is, then a patent may not be granted, thus keeping the technology out of the public record. When a U.S. company wishes to sell identified critical technology to another U.S. company, multinational company, or foreign company, the sale must be reviewed by DOD. The laws vary, depending on the specifics of each case, but basically the U.S. government has the right to stop a pending sale. Congressional action would be required to override this decision.

The Departments of State and Commerce also maintain lists of countries that are automatically considered off limits for release of critical technologies. There are six countries on this list, including Iraq, Iran, Cuba, North Korea, Libya and the Sudan. While export of critical technologies may be allowed to most other countries, export to the nations on this list is out of the question.

The penalty for unlawful export of items or information controlled under the ITAR is up to 10 years imprisonment, a fine of $1,000,000, or both (22 U.S.C. 2778). Companies found to export information controlled under the Export Administration Regulations (commonly called the CCL referred to above,) can also be fined up to $1,000,000, or five times the value of the export, whichever is greater. An individual named in such an action can be imprisoned for up to 10 years, fined up to $250,000, or both. (50 U.S.C. 2410). Companies cited for export control violations are typically barred from obtaining export licenses for at least three years, and can potentially be barred from doing any business with the government.

The MCTL was developed as a three-part document, Weapons Systems Technologies (WST), Weapons of Mass Destruction (WMD) and Developing Critical Technologies (DCT). Each section addresses a major area of technology vital to the security and warfighting capability of the United States (see Table 1). Areas of greatest concern to the AMPTIAC community like high performance materials, advanced materials processing methods and improved manufacturing techniques are covered in both the WST and the DCT (see Table 2). Please note that Tables 1 and 2 address the broad materials classes that contain some critical technologies. Whether or not a material is deemed critical is entirely dependent upon its performance characteristics. For example Table 2 denotes tungsten as being addressed in the MCTL. However, this material is only deemed critical when it is processed in such a way that it has an elongation greater than 3%, a yield strength greater than 1250 MPa, an ultimate tensile strength greater than 1270 MPa, and a density greater than 17.5 g/cm^3. The reader is referred to the MCTL itself to determine the critical performance indicators for other materials of interest.

It should be emphasized that the MCTL is not a control list; it is a list of technologies that are of particular military importance. However, for a number of reasons (e.g., worldwide availability, controllability, etc.), some critical technologies listed on the MCTL are not subject to export controls. For the convenience of the reader, the MCTL lists the control status of the MCTL entries.

As DOD researchers or engineers working with new materials, processing methods, and manufacturing techniques, it is our responsibility to use sound judgment and protect the safety of our uniformed services on the field of battle. The case studies following on the next page will more fully illustrate some of the considerations involved when dealing with critical or potentially critical technologies.

For more information about the Militarily Critical Technologies Program, please consult the MCTL website ... www.dtic.mil/mctl or make inquiries via email at mctl-admin@ida.org.

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HYPOTHETICAL CASE STUDIES:

The following hypothetical examples are meant to provide the reader with real-world examples of critical technology questions and issues. These should only be used as guidance in the consideration of critical technology issues and in no way supersede the guidance provided by the MCTL, or the departments of Defense, Commerce or State. In cases where the control status of a technology is not clear, control information can be obtained from the Department of Commerce, Bureau of Industry and Security (formerly the Bureau of Export Administration), by requesting a Commodity Classification. (www.bxa.doc.gov or (202) 482-4811)

Case 1

A researcher at an Army lab working with titanium diboride (TiB_2), develops an armor sandwich structure of three TiB_2 plates between a front and back plate of woven carbon fiber cloth impregnated with epoxy resin. The TiB_2 plates are 99% dense. This structure is then mounted to a Nomex honeycomb backing surface and tested in a standard impact regimen with a fragment-simulating projectile at various velocities. The material preparation and specifics on thickness of each plate in the system, as well as test results are detailed in a paper to be presented at an unclassified conference.

According to the MCTL, (Weapons Systems Technologies {WST}, Section 11.1, Armor and Anti-armor Materials) ceramics with greater than 98% theoretical density, in layered structures specifically intended for absorption of kinetic energy, are militarily critical. Titanium diboride is specifically cited as a material of special interest, as well as the arrangement of layered structures as described above. This paper describes a technology which, though perhaps not classified, definitely falls into the category of militarily critical, and is potentially subject to export control. Dissemination of this information without proper clearance could very well be illegal. Check the MCTL column "Control Regimes" to determine whether the particular material is controlled.

Case 2

A scientist at an Air Force lab develops a composite superconductor with a cross sectional area of approximately 35 square micrometers. Its critical temperature (T_c), below which the material functions as a superconductor, is 30K with no imposed magnetic field, but will remain superconducting with an imposed magnetic field of up to 1 Tesla. The composite is fabricated in lengths up to 40 meters. The scientist wants to publish the results in a technical journal.

This example does not fall within the specific parameters outlined in the MCTL (WST, Section 11.2, Electrical Materials). However, sound engineering judgment should be used to ascertain the implications that this innovation has on the science. For instance, does divulging this information enable adversaries to leap ahead of current capabilities? Or does specific information in the intended publication enable further innovation that would place U.S. superiority at risk?

Case 3

A university team working on a Navy project develops a foam material that has embedded semiconducting ceramic whiskers. Five millimeters of this foam is found to attenuate 6 dB of a radiant 1.7 MHz noise signal. With additional modifications, the foam can attenuate 20 dB of a 14.8 GHz signal. The team has also developed computer code that enables this material and similar compositions to be modeled and accurately predicts the signal attenuation characteristics. Experimental validation of the results is carried out at a Navy lab. The principle investigator on the project is invited to speak at an international conference in Belgium hosted by NATO.

This case illustrates one of the more elusive aspects of critical technologies: academic research. The US Government has shifted its policy on academic freedom and release of 6.1 Fundamental Research results to the public. At times university researchers have been restricted, and at other times they have had large amounts of freedom to discuss any Basic Research. The current stance (as of March, 2002) allows a significant level of academic freedom, but there is congressional pressure to limit it. The MCTL specifically calls out performance of signature reducing materials and systems, as well as the associated test procedures, simulation software, and test hardware (WST, Section 16, Signature Control Technologies). The parameters of signal attenuation outlined above fall above the "tripwire" values set forth in this section, thus for non-academic researchers this work would require evaluation by the DOD before it could be disseminated or exported. Academic researchers should address this to their sponsor or other appropriate officials. Low-observable and counter-low-observable (LO/CLO) technologies have their own offices within each service that are responsible for review of potential export issues in this field. Contact information and procedures on this topic can be found in the MCTL, Section 16.

Case 4

A defense contractor develops a lightweight, 125-cm mirror, which has potential *application to an orbital surveillance satellite. A British company expresses interest in adapting the mirror for use in an orbiting astronomical observatory to be launched by France's Arianne.*

The parameters as described are somewhat tricky to evaluate. If a radiation reflectance level were quoted, it could be evaluated against the values in the MCTL, but the size of the mirror and the statement that it is "lightweight" also require attention. The MCTL calls out (in WST, Section 17.2, Optronics) that low area density space optics with apertures greater than 1 meter are critical. This technology should be treated as if it were a critical technology until a review by DOD has been performed. For any technology that is deemed critical and regulated by the CCL, ITAR, or other specific control regime, the company developing the mirror is responsible for controlling the technology, even if there were no government funds used in its development. In cases of unclear or developing technologies, a determination of commodity jurisdiction may be desirable. Information on this procedure may be obtained through the Department of State.

Case 5

An Army researcher develops a CAD-based simulation suite that predicts final shapes of ceramic castings. No new materials were developed, nor was the fabrication method altered. A number of multinational ceramic manufacturing companies have heard of the software and are interested in applying it for everything from engine components to biomedical parts.

While the list of MCT does not specifically name CAD-based simulation software packages, it does address rapid prototyping software. For this case, where the software would be used to significantly reduce manufacturing development efforts, lower costs of manufacturing through reduced waste and rejects, and speed development of novel parts, it could definitely be judged militarily critical. This technology should be evaluated before it is exported.

History of Export Control Regulations

The concepts of export control and militarily critical technologies have been part of America for most of its history. In 1774, the First Continental Congress declared illegal the importation of British goods as well as the export of goods to Britain. Since that time, the United States has imposed export controls for a variety of reasons through numerous executive and legislative actions. Several laws still in effect today (with modifications) were enacted soon after World War II. For example, the Export Control Act of 1949 gave the U.S. Department of Commerce (DOC) the responsibility of administering and enforcing export controls on dual-use items and, for the first time, defined three reasons for the imposition of these controls: national security, foreign policy, and short supply.

The DOC's Bureau of Industry and Security (formerly the Bureau of Export Administration or BXA) is responsible for issuing Export Administration Regulations (EARs), which define the technical parameters for issuing export licenses. This listing is referred to as the Commerce Control List (CCL) and some may find its length and extensive use of technical terms intimidating. The detailed listing of technical parameters in the CCL establishes precise, objective criteria that should (in most cases) enable one to ascertain the appropriate control status. Broader, more subjective criteria would cause exporters and re-exporters to be more dependent upon DOC interpretations and rulings. Moreover, much of the CCL's detail is derived from multilaterally adopted lists. This specificity serves to enhance the uniformity and effectiveness of international control practices and to promote a "level playing field." The detailed presentation of elements (e.g., licensing and export clearance procedures) enables the exporter to find in one place what he/she must know to comply with pertinent requirements. Of special importance is the detailed listing of License Exception criteria, which enable the exporter to determine quickly, and with confidence, whether he/she needs to obtain an export license. Finally, some of the EAR's detail is specifically aimed at avoiding loopholes and permitting effective enforcement.

Almost 20 years after enacting the Export Control Act, Congress enacted the Arms Export Control Act (AECA) in 1968. This legislation established the International Traffic in Arms Regulations (ITAR), which the Department of State (DOS) Office of Defense Trade Controls (DTC) administers. The ITAR includes the United States Munitions List (USML), which defines articles and services related principally to national defense and for which licenses are required.

In 1979 Congress enacted the Export Administration Act (EAA), which superseded the 1949 Export Control Act. The EAA required the Department of Defense (DOD) to produce the Militarily Critical Technologies List (MCTL). The language states:

"The Secretary of Defense bears primary responsibility for developing a list of militarily critical technologies . . . . The Secretary (of Commerce) and the Secretary of Defense shall integrate items on the list of militarily critical technologies into the control list . . . with all deliberate speed. . . . The Secretary of Defense shall establish a procedure for reviewing the goods and technology on the list of military critical technologies on an ongoing basis."

The basic purpose of the MCTL is to define technologies that are critical for continued U.S. military superiority. The list is used primarily to provide technical justification and rationale for new proposals and to ensure the continuation of specific technology controls enforced under U.S. regulations and other multinational agreements. It is also used as a reference tool for evaluating potential technology transfers and for determining whether technical reports and scientific papers are eligible for public release.

The first version of the MCTL was published in 1981. Since then the list has been updated seven times and is currently published as an unclassified document (although some parts are limited distribution). The current edition of the MCTL is on the Internet (http://www.dtic.mil/mctl) and is continually being updated as progress is made on the technologies described in the basic document. Moreover, the Internet has provided the opportunity for more people to comment on proposed changes.